

# Remote Sensing and GIS Application: An Overview

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**Abstract** – For purpose of military reconnaissance, the world wars had spurred advanced developments in remote sensing-viewing, imaging and identifying the things from the space with the aid of space technology. Objective of remote sensing and its application have been obtained with different space aid e.g. balloons, missile, aero plane and spacecraft with the application of multitude of sensors be like photographic visual device, multi spectrum scanning device and several other remote sensing devices. These space technologies have yielded interesting scientific information about the Earth's resources and the atmosphere. Other applications envisaged are forecasting natural resources, estimating crops and monitoring crops disease, surveying minerals deposits, geographic information collection besides the increasing military applications, ubiquitous spying military applications through this space aid. GIS (geographic information system) defined with other sub name geospatial information system is instrumental in captivating, accumulating, diagnosing also enterprising data and appertinent virtue spatially contexted to the globe. Remote sensing and GIS al-together find many applications in study and management of natural resources, atmospheric change, water resource management etc.

**Keywords** – Remote sensing, Sensors, Multispectral scanners, RADAR, GIS, Satellites, Camera, Imaging, Resource management.

## I. INTRODUCTION

Louis Baguerre, French explorer has set a milestone by contriving photography in 1839 and expanded man's potency to unearth the upholstery athwart their own imagination. First time historically Gascard Felix Tournachon has taken aerial photograph from 100 meters above by captive balloon of Paris in 1858. In 1903, Julius Neubronner designed and patented a breast mounted aerial camera and it could take negative of 38 mm square. Wilbur Wright, the first man who has taken first photograph from an airplane over Centocilly in Italy in 1909. Remote sensing was first used in the United States in 1960 for photogrammetry, photo-interpretation and photo-geology application.

Transportation of information from object to observer by means of electro-magnetic radiation is known as remote sensing. Apropos to Larry Morley, remote sensing is mensuration also explication of electromagnetic eradiation mirrored from, broadcasted by dint of or addicted and protracted by atmosphere, hydrosphere and by matter at or alongside of the

earth stratum for the motive of sightedness also management of Earth's modalities and atmosphere. In other view, remote sensing on any type of space born platform houses sensors to view the spectral, spatial and radiometric relations of objects and materials of interest at the distance. It does interaction between radiation and the object of interest and conveys information required on the nature of object e.g. reflection coefficient, emittance, roughness. With this technique, we can take synoptic view, repetitive coverage and up-to-datedness image of things at ground and underneath. Remote sensing images are an unprecedentedly powerful and efficient media by which we can make study of objects of interest that are usually located in remote, inaccessible and inhospitable environments by means of sensors mounted on air or space-borne platforms [1]. Space-borne platforms such as high flying aircraft, manned and unmanned spacecraft has provided new vantage points in the field of remote sensing. It has four associated aspects-sensors, platforms, synthesis of images taken in different wavelength/bands and automatic data processing. The concept is explained in below figures. Figure.1 well explains wavelength vs. reflectance for different land cover and in figure.2 three different objects are imaged by sensor in limited number of bands w.r.t electromagnetic characteristics despite having affect of various factor on signals. Figure 3.explain about how satellite images obtained physically with different satellite and of different resolution.

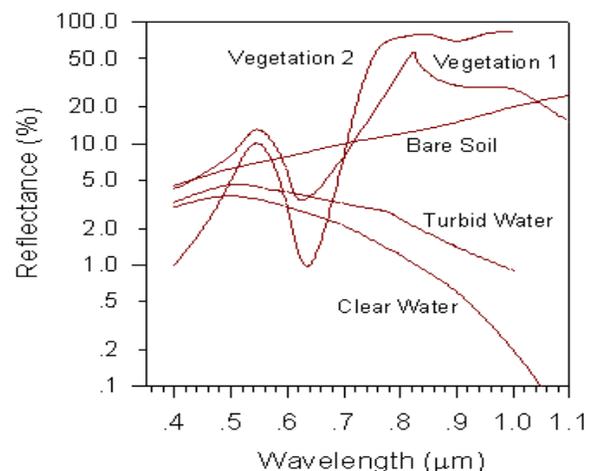


Figure 1 Spectral reflectance profiles for different land cover

Remote sensing with the aid of aerial photography found as a tool that is used to view, analyse, characterize the things and decision making about various resources of ground and atmosphere around us. This technology is very much advanced and majorly used on three fronts: [2]

Remote sensing technique employ devices such as camera, lasers, radio frequency receivers, radar systems, sonar, seismographs, gravity meters, magnetometers and scintillation counters to measure/image the objects of interest. A variety of sophisticated sensors e.g. camera systems, electro-optical and spectral imaging scanners, multi spectral scanners, thermal mappers, side-looking airborne radars and microwave radiometers etc have increased the capabilities of remote sensing technology today. In nutshell the progress in the field of remote sensing since the 1950's can be characterized by the development of multiple data acquisition capabilities and multiple data analysis techniques.

Geographic Information System (GIS) is an integrated system of computer hardware, software and trained personnel linking topographic, utility, facility, image and other resource data that is geographically referenced. The Chorley et al. (1987) brings facts about GIS. It is modern tool which acquire, checks, analyze, manipulate large quantity spatial and geographical referenced distributed data. For exemplification, water perfection data can be connected with the specimen venue, signified by the spot. Data found on harvest products can be allied with regions or practical tract of land characterized on the map by polygrams.

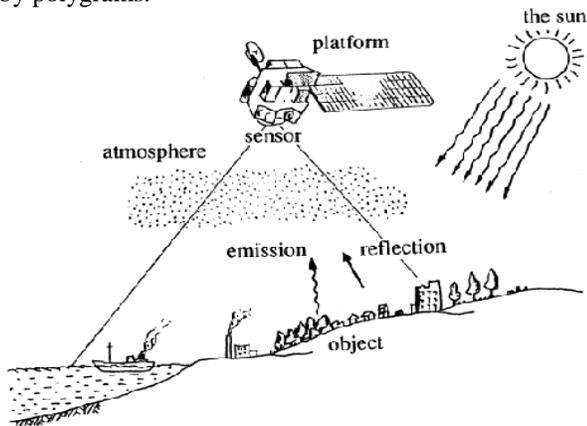


Figure 2 Remote sensing data collection method

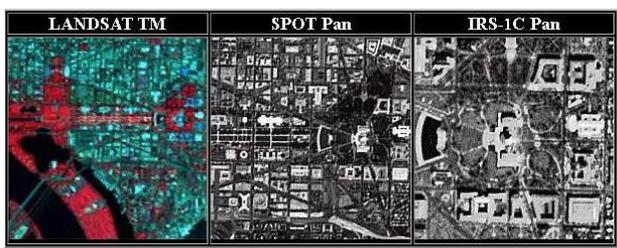


Figure 3 Satellite image of different satellite and of different resolution: [2]

The paper is further organized as follows: First part describes brief introduction about Remote Sensing and GIS and brief history about it. Second part describes remote sensing application. Third part deals about GIS and its definitions. Further sub section discusses about GIS applications. GIS and remote sensing applications are explored in fourth section and in last section essence over the research work and adoption are concisely put for perusal of renowned researcher.

## II. REMOTE SENSING APPLICATIONS

Remote Sensing technique have more than hundred applications in different fields, some are described below: [2]

### A. Agriculture Application

In developed as well as in developing countries agriculture plays a dominant role in economies. Remote sensing images are utilised at vast scale in classifying crops types, examining their health and viability and monitoring farming practices. Remote sensing applications in agricultural field (see fig.4) are:

- Crops classification, estimation and assessment
- Crop yield estimation
- Soil characteristics mapping
- Farming practices monitoring etc.



Figure 4 Remote sensing image for agriculture application [8]

### B. Forestry Application

Forests are valuable resource of providing food, shelter, wildlife conservation, fuel, paper and medicinal ingredients. Forest balances earth's CO<sub>2</sub> supply and exchange. It plays an important role in maintaining link between the atmosphere, geosphere and hydrosphere. Remote sensing applications in forestry (see fig.5 & 6) are:

- Reconnaissance mapping
- Commercial forestry
- Environmental monitoring



Figure 5 Forest side Satellite image [8]



Figure 8 Remote sensing application in hydrology [8]

*E. Sea Ice*

Substantial part of the Earth surface is covered with ice. It has impact on commercial shipping, fishing industries, coast guard, construction operations and global climate change studies. Remote sensing finds applications in this field as shown in fig.10).



Figure 6 Non - commercial Forest side Satellite image [8]

*C. Geology Application*

Remote sensing applications in Geology include landforms study, mineral and hydrocarbon resources exploration and exploitation study etc. (see one example in fig.7)



Figure.7 Exploration of minerals as seen through satellite images [8]

*D. Hydrology Application*

A water resource available on earth surface, flowing above ground, frozen in ice/snow or retained by soil is studied in hydrology application. (see figure.8 & 9)



Figure 9 Remote sensing application flood delineation [8]

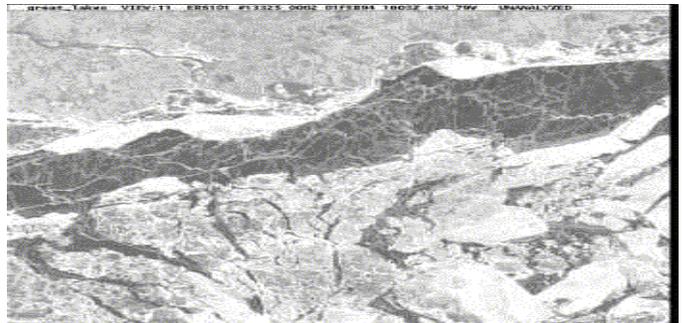


Figure 10 ERS-1 image showing Ice formation Northern Lake Erie, 1Feb, 1994 [2]

*F. Land cover and Land use Application*

Land cover means ground surface cover and land use or application means utilization of it for some purpose. Remote sensing technique does imaging of land cover from which land use can be surveyed and estimated with application of remote sensing image (see fig.11).



Figure 11 Remote sensing application in land cover and Land uses [8]

*G. Mapping Application*

Remote sensing images and data are used in managing land resources. Remote sensing mapping is done in following way: (see figure.12, 13 & 14).

- Plainmetry
- Digital Elevation Models (DEM's)
- Baseline thematic mapping / topographic mapping



Figure 12. The red square in Beijing, China, 22 Oct, 1999: four meter resolution color image [2]

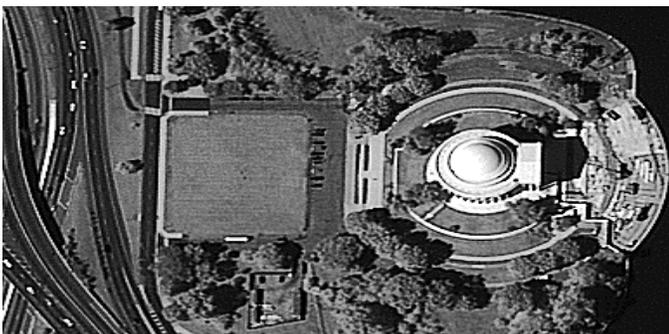


Figure 13 Jefferson Memorial, Washington D.C. 30 Sep, 1999. first public image, one meter resolution B&W image [2]

*H. Ocean and Costal Application*

The oceans serve food and provide bio-physical resources, transportation routes. It also provides weather system formation, CO<sub>2</sub> storage and earth's hydrological balance. Coastal lines interface between the ocean and land. Coastal lines also provide

assistance in achieving economic development and changing land-use patterns. They are biological diverse inter-tidal zones and high urbanized zone (see fig.15 & 16).



Figure 14 Thermal image of the lakes of Erie and Ontario obtained from TM6 from Landsat [2]

Some other applications are:

- Sea specimen discretion
- Tempest prediction
- Fish storage and oceanic mammalian estimation
- Oil relapse
- Vessel mapping
- High tide and tempest impact evaluation

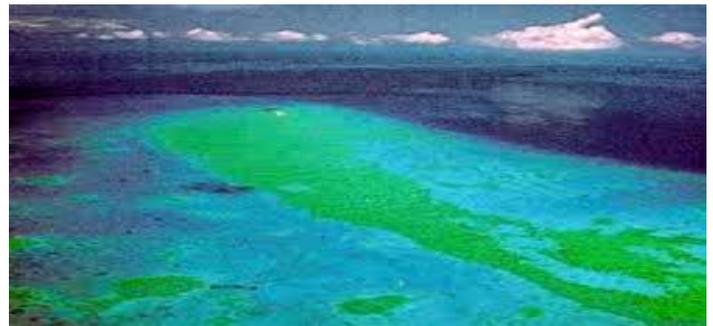


Figure 15 Satellite image of coastal areas [8]

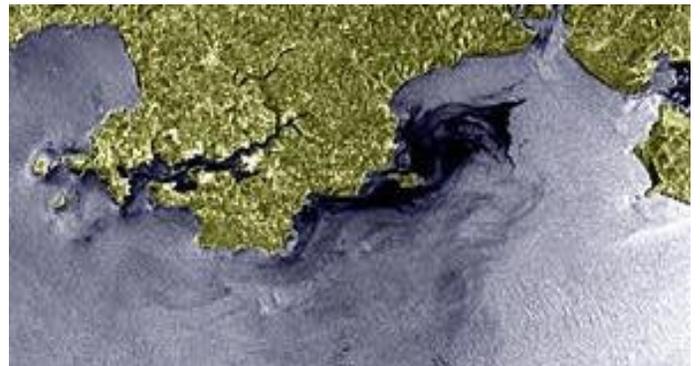


Figure 16 RADARSAT image taken a week after the spill near the town of Milford Haven, Wales on 15 Feb, 1996 [2]

### III. GIS APPLICATION

Information system improves ability of decisions making. This has connectivity of several manipulations e.g. projecting the contemplation, accumulation of data, storage also dissection of data and application of nascent Intelligence in specific judgmental procedure. Geological information system software and hardware is designed to process and interpret referenced data in form spatial or geographic coordinates. Basically GIS application has three forms that may depict platform to evolution of lonesome GIS perception:

#### A. Inventory Application

GIS information in many applications is used as inventory information for a given geographic area. These traits are delineated in GIS as stratum or context of data. The consequence at the stage of such usage textures in up-to-dating and ingenious data indemnification.

#### B. Analysis Application

Some application requires complex analysis of geographical area. In first stage contrivance intelligence of such territory is acquired and afterward sophisticated queries over multiplex stages can be featured applying spatial and spatial synthesis technics.

#### C. Management Application

Advanced spatial and modeling techniques provide a very good support in achieving managerial decision and policy making by managers. In this application geographic data handling, manipulation, analysis and modeling is included to solve the problem.

### IV. APPLICATION OF REMOTE SENSING AND GIS

#### A. Ecosystem Management

Remote sensing [3] has application in ecological inventory monitoring and ranging by getting image and processing of repeated photography of ground element through space segment specially by satellite monitoring. Remote sensing can improve the repeatability of ecological monitoring and avoid certain research impacts such as the trampling of microphytic soil crusts in arid landscapes. Ecological data can be acquired through remote sensing image and GIS data along-with computer application. This will provide valuable information to land managers by allowing collation, storage, integrated analysis and dissemination of spatial data as well as associated data, text and graphics files.

#### B. Mangrove Forest Management

J.G Kairo et al [4] have brought the status of mangroves trees in Kenya. This could have been possible with the use of remote sensing data. Vegetation maps provided by GIS processed data

make it possible to store, retrieve and analyze information. With this available information managers can proposed various treatments, planning, implementation and monitoring of vast area. Kairo exploration has clenched about volumetric concentration of mangroves based in Ndau and Siyu territory. Rhizophora-type forests which were dominant and occupied 24.14% and Ceriops-type forests occupied 15.38% of the mapped forested area of 16,035.94 hectare of Kiunga MPA. Mapped non-forested areas were mainly mudflats, rangelands; cultivate land, area with sand, sea beach and water-spread areas. Segmentation of remote sensed portrays and application of GIS makes it eventual to interpolate forest be located inside also imminent to Kiunga MPA and fertile and non- fertile regions.

#### C. Management of Shallow Tropical Lake

J.M.Mironga in his review paper [5] finds wide applications of remote sensing and GIS data in assessment of shallow tropical waters. This area has much importance for people, contains plants and animals. Population growth in catchment area has increased resulting intensive use of land. GIS data has been very useful in monitoring weed pattern spreading in tropical water, land usage, wet land deletion, status of productivity and nutrient and their efficient management. Satellite images obtained are integrated with GIS data and useful spatial and temporal changes over large geographic areas of tropical water are predicted.

#### D. Application in Agrometrology

Agrometeorology [6] is utilized in understanding the relative importance of ecosystems, organizing the field activities and optimizing the use of natural resources. GIS has made it easily available and allowed managers to use incredible quantity of data for digital map, database, models etc. GIS data are very much important in fast cross-sector interaction and production of synthetic and lucid information for decision-makers. Applications of GIS and remote sensing in agro meteorology illustrate evolution, expected future developments in the environmental and land resource management.

#### E. Change Assessment in Coastal Environment

Remote sensing and GIS data find wide application assessing rapid growth and economic benefits of entire Niger Delta region [9]. In Niger Delta region, there have been unprecedented economic expansion but it has faced environmental challenges due heavy exploration of oil and gases, housing development, road and city development and demographic changes. All above issues were easily accessed by the use of remote sensing and GIS data.

#### F. Evaluation of Urban Expansion and Surface Temperature change

Q.Weng [10] in his research reports reviewed that integrated application of remote sensing and GIS data urban growth and its

impact on surface temperature can easily assessed in any region of world. With the aid of remote sensing image land use/cover, change detection, urban growth pattern analysis can be planned. With the Weng study it was concluded that though urban development is very much necessary but it had raised surface radiant temperature by 13 K in urban area.

#### G. Application in Water Resource Management

Integrated remote sensing and GIS techniques applied by the Center for remote sensing and mapping science, University of Georgia, Georgia [11] to identify areas of potential non-point source of pollution in large watersheds. Intelligence about soil utilization, soil vesture, lands, topography also shatter were secured through American SPOT spacecraft remote sensing imagery and data with 20-m resolution, etherial pictures, drafts also field perusals are consolidated into digital database. Digital database obtained are integrated with ARC/INFO GIS software. Outcome obtained is applied to categories delicate regions of NPS contamination of 5,000 km<sup>2</sup> water-shed zone outflows into Lake Marion, South Carolina. Therewith above, spatial runoff model has been evolved by CRMS which admeasures soil deficit in terms of terrain slope and remoteness from adjoining streams. This model is being used to estimate sediment input to Lake Marion, a contributing factor to the excessive growth of aquatic macrophytes in the lake. It is worth emphasizing that the procedures employed for these studies can be extended to much water resource related problems in the Southeast, provided careful consideration is given to source materials, database construction and GIS analysis techniques.

#### H. Other Applications

- Desert Locust Monitoring System
- Drought warning and assessment
- Fisheries management
- Flood Hazard and Risk Assessment
- Forest Fire and Degradation Assessment
- Flood control, risk zones, and damage assessment
- Mineral prospecting
- Prediction of snowmelt runoff
- Urban planning
- Water resources management
- Water and Wind induced Soil Erosion Assessment and Monitoring
- Watershed management
- Wasteland management

### V. CONCLUSION ON REVIEW REPORT

In conclusion report it is worth to mention that there is apparent and prudent connection amidst remote sensing and GIS data for enterprising base-map, phrasing of planning resolution which functions as invigilating resources during execution condition. GPS (Global positioning system), which assent positions to be determinated to  $\pm 10$  m throughout Earth's plane has amassed

one more plume in this technic. Figure.17 decode good relation amidst them. Benefit of merging of GIS information and Remote Sensing data are well understandable with this review. We can scrutinize them in two diverse forms: on first form, GIS can be utilized to improve information ejection probability of remotely sensed data. On second form, remotely sensed data can be applied in up to dating GIS information.

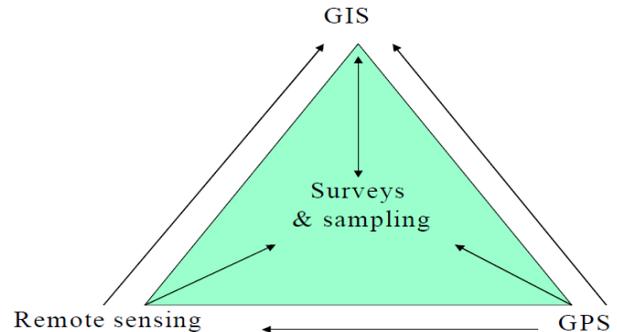


Figure.17 .Relation of GIS, GPS and Remote Sensing in view of their applications [8]

In era of science, technology is so blossomy that one can enumerate number of palms tree in territory applying remote sensing imageries obtained through satellites. Remote sensing from space with aerial and ground observation will form a major part of future resource management efforts.

#### LIMITATION

Such advanced space technology remote sensing and GIS data is really useful to a country like India, but it is utilized in some specific areas. The economic viability of space application has been proved by industrially advanced countries and India, a fast growing economic country; it may be plenty good to utilize the technology and data. In fact, Space technology e.g. Remote sensing data and GIS data is very useful over conventional methods where plenty of man power is required to finish or provide a fruitful product. Its benefits, therefore, need to be properly addressed by an impartial group of Scientists, Economists and Sociologists, so that our data should be utilized in more and more in development of country. Also, a strong interaction between space Scientists and Geophysicists is necessary for better utilization of remotely sensed data and GIS data. India like other space technology countries is growing very fast in such technology and in same pace its utilization in all areas also should be ensured.

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